# STATE & PRIVATE FORESTRY
## FOREST HEALTH PROTECTION
### SOUTH SIERRA SHARED SERVICE AREA

**Report No. SS23-02**

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**From:** State and Private Forestry, Forest Health Protection, South Sierra Shared Service Area

**Subject:** Assessment of Hazard Trees caused by Drought, Insects, and Diseases from 2000-present, Stanislaus National Forest

**Introduction**

Native insects and diseases are important agents of change and disturbance in western conifer forests. Unprecedent drought cycles since the turn of the century have caused significant levels of bark beetle-associated mortality in California, particularly those in the southern Sierra Nevada. Several counties in these affected areas were declared emergency zones that required state and federal intervention due to the staggering number of trees killed by bark beetles that created extremely hazard situations to public and property (CA Tree Mortality Task Force 2017). Calaveras and Tuolumne counties that include sections of the Stanislaus National Forest (STF) fell into high priority designation. As the recent drought cycle has continued in severity and length plus wildfires continue to ignite across the state, the number of dead trees on the landscape continues to build and pose potential hazards.

Stanislaus National Forest is proposing to evaluate over 125,000 miles of road and over 260 administrative sites throughout the Forest to remove potential hazards that pose safety concern. Using criteria from FHP Report # RO-22-01 (Angwin et al. 2022), proposed roads will be evaluated for trees that fall within criteria deemed for removal. Dead and dying trees caused by wildfires and other disturbance agents are all accounted for. Some living trees may rate within criteria necessary for removal, as their eventual failure could be fatal. Dead trees are recommended to be treated to reduce hazardous situations, likewise trees that pose eminent hazards should be evaluated carefully. Specific guidelines and treatment measures are outlined in the Determination of NEPA Adequacy (DNA). As stated in the DNA (April 2023):

*The primary purpose of this project is to provide for safe use of National Forest System roads, high-use motorized trails, and facilities such as trailheads, administrative sites, and dispersed and developed recreation areas. If hazard trees are left unabated, they may fall on roads, motorized trails, and facilities and either cause direct injury or death to people (such as a tree falls on a tent with a family sleeping inside) or indirect injury or death (for example, a tree falls across a road and a driver strikes the downed tree after coming around a blind curve). Providing a safe environment for both public and administrative use of affected roads, high-use motorized trails, recreation areas and facilities is a priority for the Forest Service. The Chief of the Forest Service*

*and the regional forester repeatedly stress that the safety of the public and our employees is our central concern. Therefore, identification and mitigation of hazard trees on National Forest System lands is necessary to fulfill the Forest Service's mission.*

High priority areas on the STF, such as those within wildlife-urban interfaces have been in the process of hazard tree removal but many areas within general forest have yet to be treated. Roads are especially important as visitor and personnel rely on roads to access recreation or utilities. Roads are not often viewed as high risk areas as most use may be transitory, but the volume of traffic or the importance of the access should be considered. Dead trees pose significant risk to roads, as many of them fall onto oncoming traffic or vehicles parked alongside roads. Forest personnel are especially at risk as lower use roads may not be cleared and access can be blocked for safety or escape. Some level of mortality or injury of trees is a given in natural systems, thereby additional trees may need to be removed during course of planned treatments if deemed potentially hazardous.

Loss over a large area can be difficult to accurately assess, more so considering the size of the national forest. Hazardous trees are defined as requiring a target to hit, and trees that have the potential to fall on public or property fall in this category. Trying to assess the number of individual trees over thousands of miles of proposed roads can be a feat, providing a broader assessment of the severity of cumulative pest activity and possible locations of highest activity in the past two decades can help understand the magnitude of dead trees overall.

**Insect and Disease associated mortality following Drought events**

In California, drought events typically incite increases in pest activity. Moderate to severe droughts can trigger large-scale insect outbreaks. High levels of tree mortality are highly correlated with drought periods in the state (Oblinger et al. 2012, Guarin and Taylor 2005). Droughts are especially beneficial to insects, as water stress decreases conifer defense mechanisms which beetles exploit for successful mass attack – particularly in larger trees (Bennett et al. 2015) especially for pines (Stephenson et al. 2019). Drought is also non-specific in that it affects all trees to some degree, increasing the susceptibility of already weakened trees and lowering vigor of surrounding healthier trees.

Mixed conifer forest types are most affected by insect activity in comparison to oak-dominated woodlands, or foothill conifer-brush types which are better adapted to drier conditions. Destructive native bark beetles prefer conifers in which to feed, reproduce, and house offspring so they rely on stressors to reduce defense mechanisms of hosts. It is because of this that bark beetle eruptions happen rapidly, jumping from localized centers to outbreak status over a landscape. At low population levels, tree losses can be singular to small groups, developing into large congregations in which up to >30% host trees species can be killed (Stephenson et al. 2019, Fettig et al.2019). Preferred conifers are often larger diameter in size which can significantly alter the composition or canopy cover of a stand.

***Image 1***. Western white pine recently mass attacked by bark beetles in 2022; crown likely to turn red in 2023. Calaveras Ranger District, STF. Photo taken 2022.

Pathogens cannot be overlooked as contributors to mortality or stress agents on trees. Root diseases cause significant internal decay in conifers and oaks, compromising structure and integrity which often leads to failure. Some root diseases are also tightly coupled with increasing susceptibility to subsequent insect attack. Native diseases are habitually hidden, not developing fruiting bodies until late in the decay stages so early detection is very difficult. Other pathogens that cause cankers may not kill their hosts but are structurally weak points that can break under strong winds or heavy snow loads. Parasitic plants are similar: heavy infection levels slowly deprive hosts of their nutrients and water, causing slow decline as nearby trees also become infected and the cycle continues. During severe drought, trees with heavy infections can die without additional damage agents such is the case with oaks.

Some mortality and injury can be direct consequences of significant water stress caused by prolonged drought and high temperatures. Incense cedars do not have a primary bark beetle like those in pine or fir but have other agents that detect stressed cedars and infest trees already dying. Pest presence in this case is an indicator of trees already declining than just weakened from low water.

Before the turn of this century, increases in pest-related activity happened on a regular occurrence about every decade that coincided with times of low precipitation. Climate conditions have been on an upward trajectory to hotter, drier conditions particularly in western North America, and I&D activity is expected to increase (Robbins et al. 2022, Bentz et al. 2010, Fettig et al. 2013). The last major bark beetle event before 2000 was noted early 1990's in white and red fir (see Figure 1) and thousands of trees were reported dead. By 2002, bark beetles had affected over 500,000 acres in the San Bernardino and San Jacinto mountains prompting immediate state emergency mitigation as dead trees threatened homes and people in mountain communities (CFPC 2003). The 2012-2015 drought event was unprecedented in its severity of such low moisture deficits – being the worst recorded in the last 1200 years (Robeson 2015, Griffin and Anchukaitis 2014). Some areas were so stricken, experiencing nearly deforested conditions and complete loss of overhead canopy due to bark beetle infestations (Fettig et al. 2019, Piles et al. 2015). And while the drought was declared over by 2017 by a return of above-average precipitation, tree mortality did continue albeit at

slightly lower levels not yet returning to average background levels. In total, an estimated 126 million trees were killed between 2010-2017 across the state (FHM ADS).

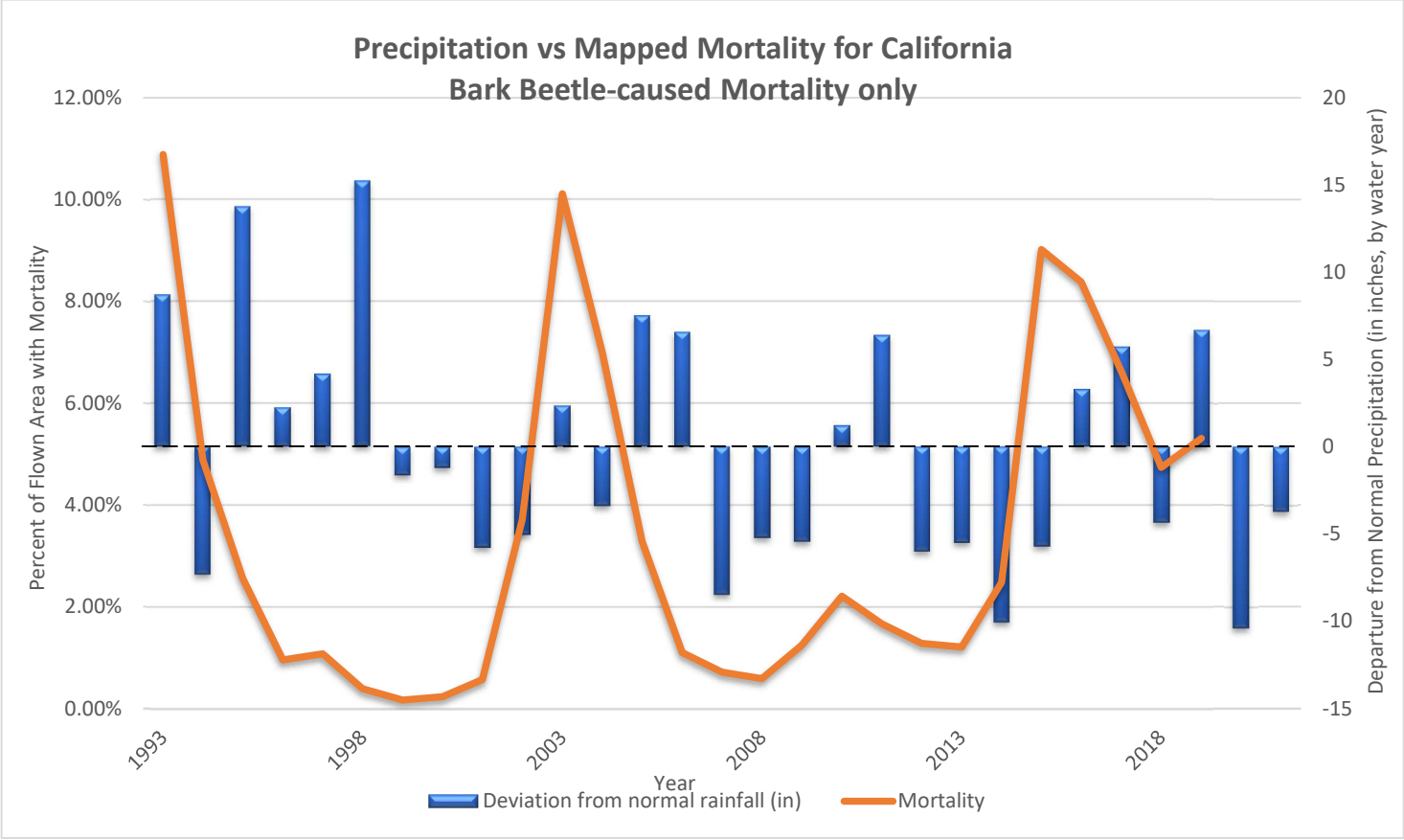


***Figure 1***. Statewide precipitation from 1993 to 2022 and corresponding trend of bark beetle mortality.

## Aerial Detection Surveys (ADS)

Forest Health Monitoring (USDA Forest Service, State and Private Forestry, Pacific Southwest Region) is a national program that conducts annual aerial flights to survey for insect and disease-associated activity in forested areas. Also known as ADS, surveys are conducted annually by trained personnel in fixed winged aircraft over most federal and state forested lands. Aerial Detection Survey is critical to monitoring disturbances such as tree mortality in forested lands over a large landscape within one year time window. ADS can provide maps of areas containing current year conifer and hardwood mortality, defoliation, and other damage (except wildfire). Surveys detect mortality or injury not accessible from the ground or areas not often visited (ex: wilderness). From this data, patterns and trends of activity can help notify land managers of emerging threats, building/collapsing activity, or other changes in the landscape. This tool is invaluable to land managers, scientists, government agencies, and general public to be able to view and assess activity occurring in their local zones. Aerial surveys have been used to locate and track activity that may pose hazard risks to public and property.

***Image 2***. Aerial photo taken over Shanahan Flat and section of Highway 120 showing large groups of bark beetle mortality. Groveland Ranger District, STF. *Photo taken in 2015*.

***Image 3***. Highway 120 showing mature sugar and ponderosa pines killed along Highway 120. Groveland Ranger District, STF. *Photo taken in 2015*.

Bark beetle activity peaked across the Stanislaus during 2014-2017 (see Appendix A) and has since spiked again by 2022. The 2013 Rim Fire that burned over 257,000 acres did cause significant conifer mortality in its footprint, but pest activity outside the fire perimeter was just as elevated. As the second year of severe drought persisted into 2014, large mature ponderosa pines and sugar pines at lower elevations were rapidly being targeted by bark beetles alongside major thoroughfares (see Images 2, 3, 4). Many areas that were predominantly pine type in Groveland Ranger District were severely hit (see Image 5). During this drought event and in recent years, a record number of dead trees continues to be detected (see Table 1).

***Table 1. FHM Aerial Detection Survey summary on Stanislaus NF of detected acres and estimated numbers of dead trees. Note: no survey was conducted in 2020.***

| Year Flown | Acres detected with mortality | Estimated number of dead trees |
|---|---|---|
| 2012 | 13,954 | 54,804 |
| 2013 | 23,245 | 81,207 |
| 2014 | 109,461 | 413,682 |
| 2015 | 176,000 | 1,251,000 |
| 2016 | 234,000 | 4,896,000 |
| 2017 | 159,000 | 2,240,000 |
| 2018 | 75,000 | 671,000 |
| 2019 | 81,000 | 499,000 |
| 2021 | 95,000 | 587,000 |
| 2022 | 140,000 | 2,600,000 |

Calaveras Ranger District was also seeing many pine-type stands dying in large groupings. Mortality was focused in these areas, so multiple years of dead trees can be seen.

By 2017, mortality had shifted to higher elevations, white and red fir were beginning to feel the pinch of hotter summer temperatures. The largest polygons were detected in white and red firs, at moderate to severe levels of activity.

The current 2022 ADS report (FHM 2022, https://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696 ) shows the Stanislaus had an estimated 140,000 acres detected with tree mortality, with about 2.6 million trees estimated dead throughout the Forest. Tuolumne County alone had 2.2 million dead trees, with 120,000 acres affected. The 2021 and 2022 ADS overlay shows that most mortality is concentrated in the higher elevations, but also in high visitation recreation areas and private lands that border the Forest (see Appendix B).

***Image 4.*** Ponderosa pines killed in differing years by bark beetles. Calaveras Ranger District, STF. *Photo taken 2016.*

***Image 5.*** Dead ponderosa pines killed by bark beetles along Ferretti Road, Groveland Ranger District, STF. *Photo taken in 2015.*

**Discussion**

Hazard trees pose dangerous threats to public and property. The widespread tree mortality following the latest drought events resulted in several foothill counties in California to declare emergency zones and heightened wildfire severity predictions. The amount of heightened tree loss over the Forest since 2014 has steadily accumulated and needs to be addressed. Mitigation of current hazard trees on many roads in the STF would provide safer access for all who use them and reduce the potential of injury or structural damage. Closure of roads is not preferable for those who desire open access to public lands. Removal of hazard trees will be conducted as budget and work force allows.

Models indicating increasing hotter drier conditions also increase the likelihood for future insect outbreaks or intensification of disease infections. Current studies of beetle-killed trees are consistent with original observations showing many species beginning to fail within 5-10 years post death (Cluck and Smith 2007). A recent study by Reed et al. 2023, found that 40% of ponderosa pines killed by bark beetles fell within five years since death, and that 10 % of incense cedar not fire-killed, failed about four years after death.

As mentioned previously, ground survey of all proposed roads for the STF Forestwide Hazard Tree Removal project is not feasible nor practical as conditions can change rapidly. FHP will assist training in use of rating criteria, and field assessments in as many locations as possible to determine which areas may need additional evaluation of identified trees. ADS can provide annual supplemental information and provide broadest overviews for suspected mortality levels, which will help the Forest to prioritize zones for analysis and treatment.

If there are any questions or concerns regarding this report, please contact FHP.

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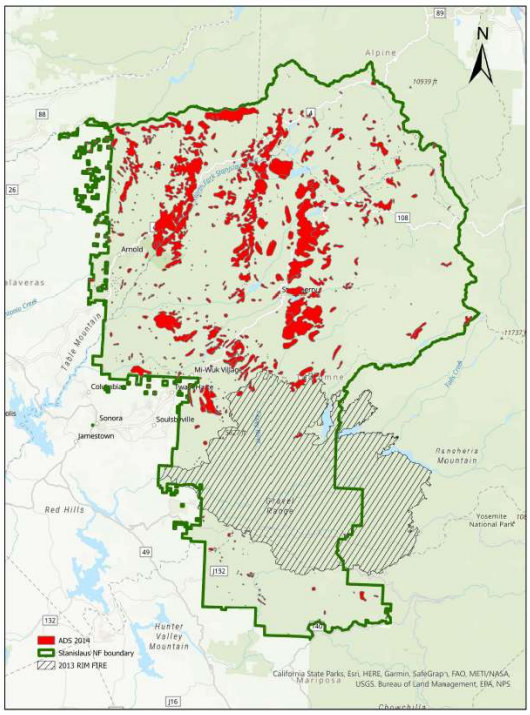
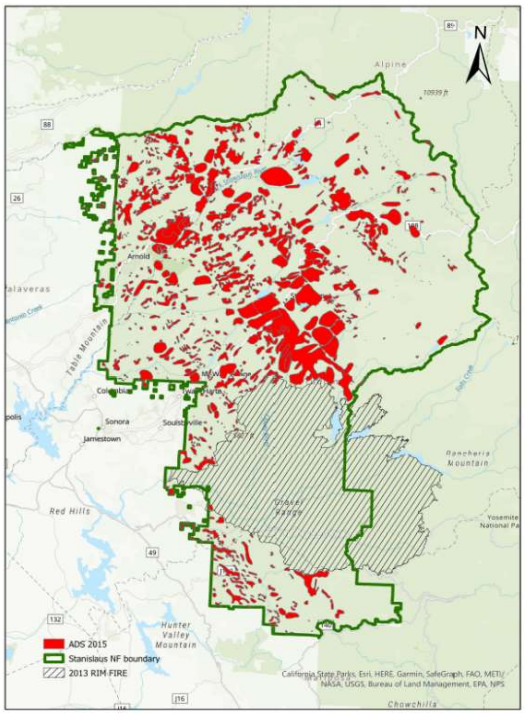
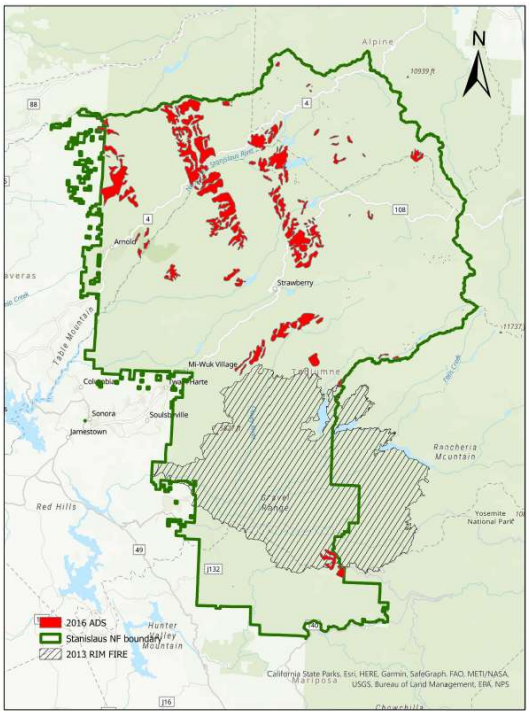
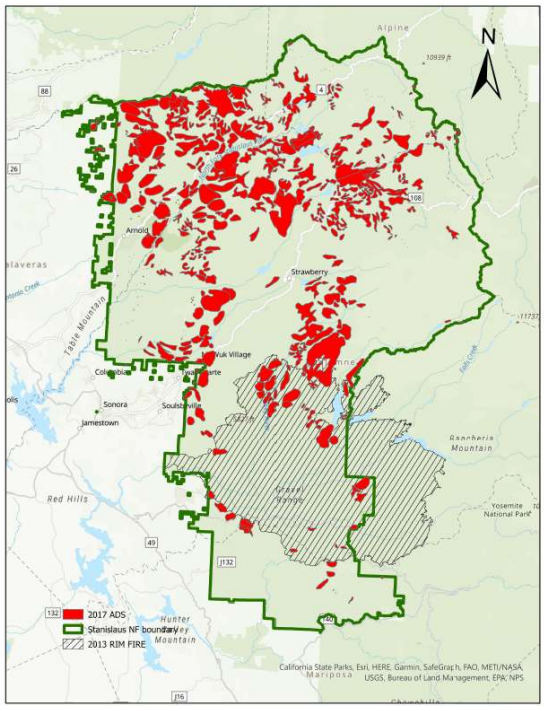
**Appendix A.** Map progression of tree mortality detected across Stanislaus National Forest from 2014-2017. NOTE: 2013 RIM Fire footprint was not flown for 5 years post-fire.



**Appendix B.** ADS maps of 2021 and 2022 tree mortality detected on Stanislaus National Forest.